“How MU's Physics Department Launched My Career in Both General Relativity and Supercomputing”

Presentation to
University of Missouri-Columbia
Physics and Astronomy Department
2026 Physics Leaders Meeting and Alumni Reunion
October 16, 2026

Dr. Larry Smarr
Distinguished Professor Emeritus, Dept. of Computer Science and Engineering
Jacobs School of Engineering, UCSD
https://lsmarr.net/

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I Attended the MU Laboratory School From K-12 in One Building

I Studied Astronomy on My Own from First Grade Through High School



MU Allowed Me as a Lab School Junior & Senior To Take the MU College Courses Analytic Geometry and Calculus I, II, & III

I Took My First Course in Computer Programming in MU Summer School 1966

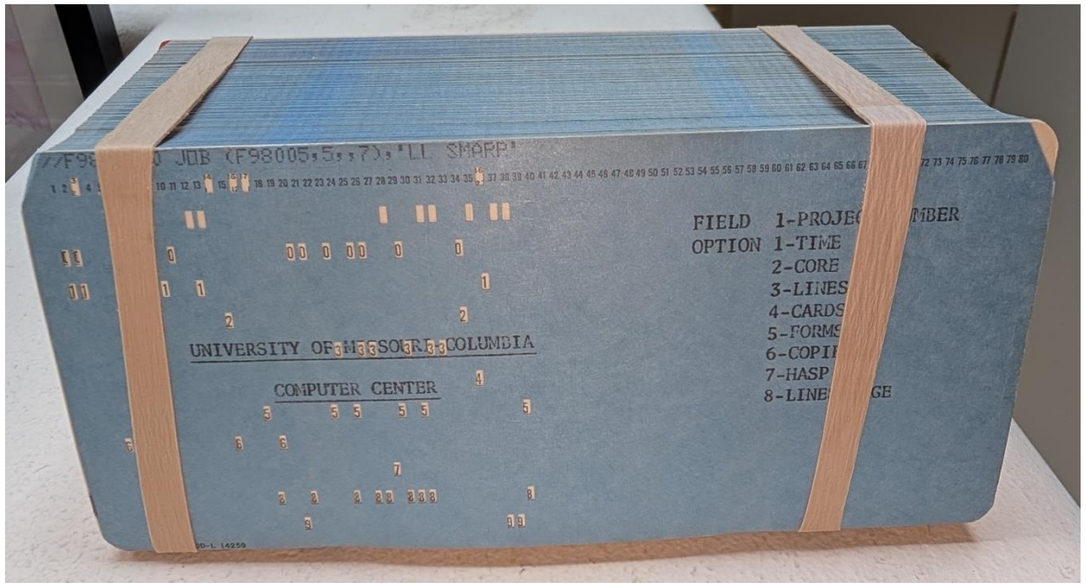
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My Early Lab School College Courses Transformed My MU Undergrad Trajectory

- **My 1st and 2nd Undergrad Years**
  - I Was Able to Take 3rd and 4th Year Math and Physics Courses
- **My Undergrad Junior and Senior Years**
  - I Was Taking Math and Physics Graduate Courses
  - I Became a Dual Honors Math & Physics Major
- **The Physics Department Became My Academic Home**
  - Several Professors Became My Mentors
  - I Was Given a Desk with the Physics Graduate Students

My Undergraduate Junior Year Honors Project in 1968: Create a Computer Program for Neutron-Nucleon Scattering

- **Solve Schrödinger's Equation with a Complex Woods-Saxon Potential**
  - Physics Advisor Prof. Brian DeFacio
  - Motivated by MU Research Reactor
- **My Research**
  - Find Numerical Algorithm
  - Write FORTRAN Program
  - Create a Punched Card Deck
  - Cross Sections Graphed on Printer
- **I Used the IBM 1130 Mainframe in the MU Computer Center**
  - My Smartphone is 1 Million Times Faster





This Launched My Computational Physics Career

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I Learned Tensor Calculus and General Relativity In My Junior Undergrad Year (1969-1970)

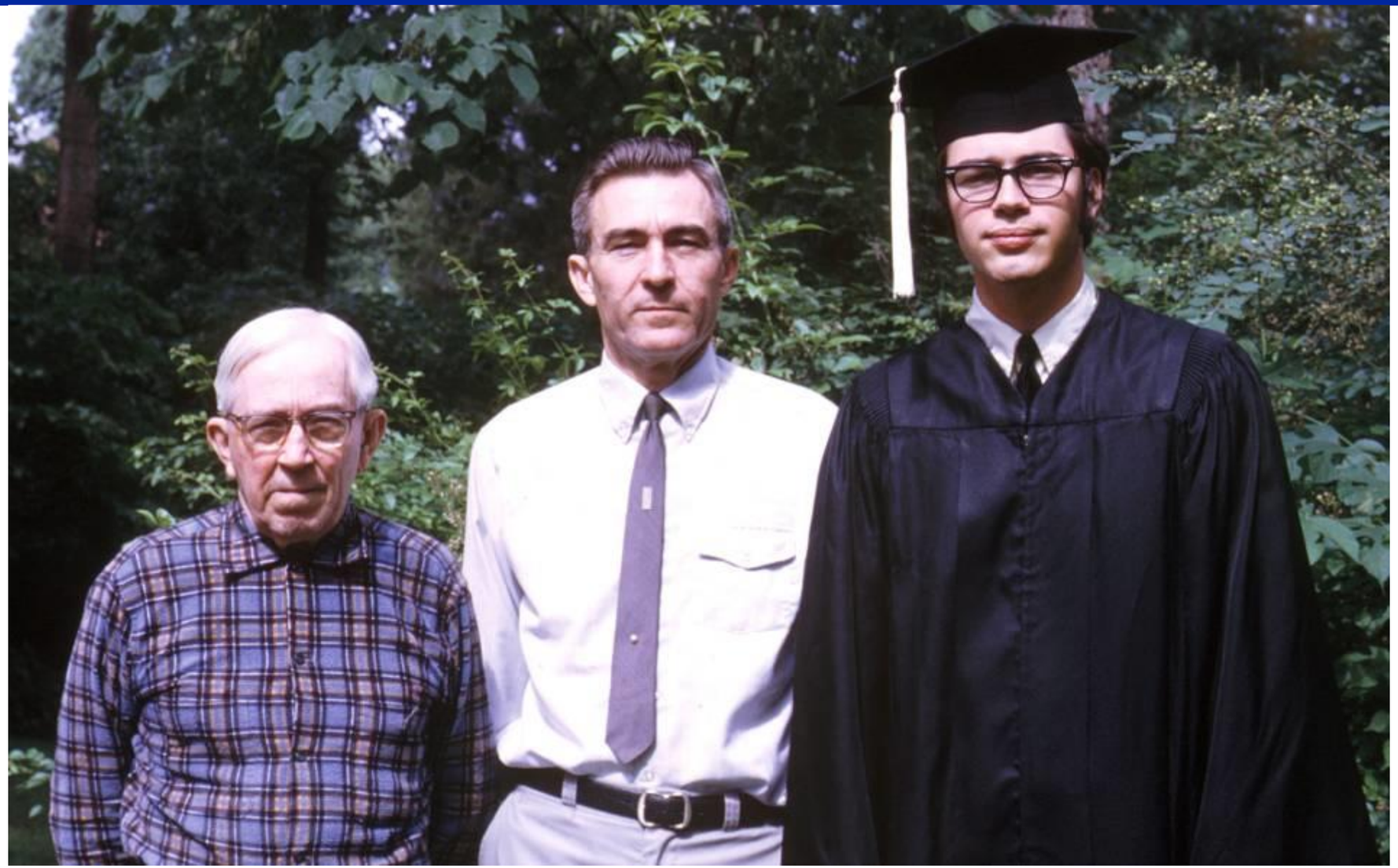
- **Upper-Level Math Courses**
- **Physics Course 432 Theoretical Astrophysics**
- **The Physics Department Xerox Account**

Princeton University's Professor John Wheeler
Coins the Term "Black Hole"
in the *American Scientist* Spring 1968
Fifty Years After the Schwarzschild Solution Was Published

This Launched My General Relativity Career

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I Graduated From MU in 1970



Grandfather Father Me

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Building on My MU General Relativity Education, In 1972 I Submitted Two Papers on Black Holes, Published by Physical Review in 1973

VOLUME 30, NUMBER 2 PHYSICAL REVIEW LETTERS 8 JANUARY 1973

Mass Formula for Kerr Black Holes

Larry Smarr*
Center for Relativity Theory, Physics Department, The University of Texas at Austin, Austin, Texas 78712
(Received 29 September 1972)

PHYSICAL REVIEW D
PARTICLES AND FIELDS
THIRD SERIES, VOL. 7, NO. 2 15 January 1973

Surface Geometry of Charged Rotating Black Holes*

Larry Smarr†
Center for Relativity Theory, University of Texas, Austin, Texas
and Physics Department, Stanford University, Stanford, California
(Received 26 July 1972)

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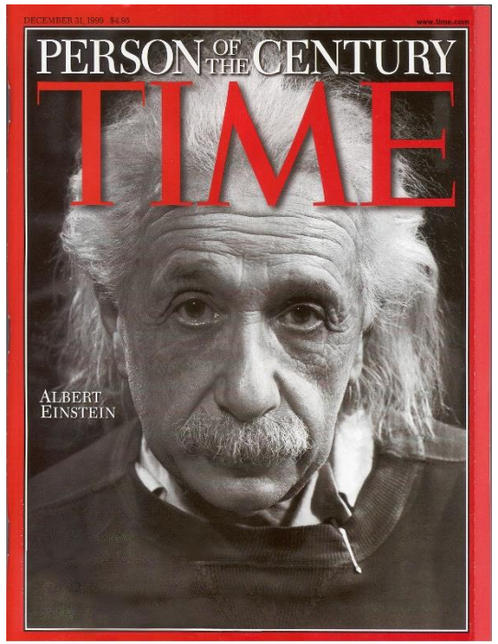
I Attended the 1972 Les Houches Summer School on Black Holes- A Summit of the Leading Physicists in General Relativity



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The Two Black Hole Collision Is a *One Hundred Year* Long Physics Research Problem

1915
Einstein Field Equations
Schwarzschild Solution for One Black Hole



2015
Gravitational Radiation From Two Colliding Black Holes Detected By LIGO



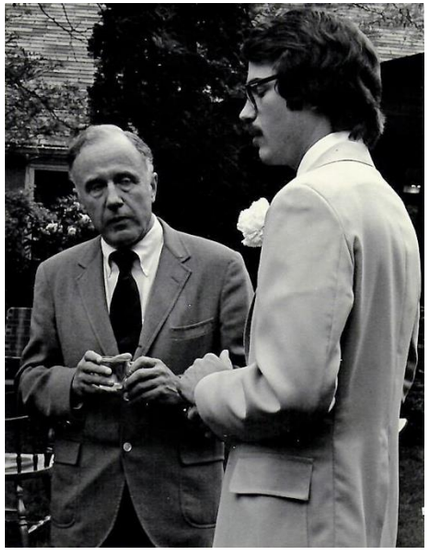
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Why Did I Attack the Two Black Hole Problem in 1972?

- Fundamental Two-Body Problem in GR
- Cosmic Censorship, Can a BH Break a BH?
- Powerful Source of Grav. Radiation?
- Supercomputers Were Getting Fast Enough
- I Was Getting Married and I Needed a Ph.D…



Bryce DeWitt
My PhD Advisor
1972



John Wheeler
At My
Wedding
1973

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My MU Start in Computational Science and in General Relativity Came Together in My 1975 PhD Dissertation

THE STRUCTURE OF GENERAL RELATIVITY WITH A NUMERICAL ILLUSTRATION: THE COLLISION OF TWO BLACK HOLES

Larry Lee Smarr, B.A., M.S.

DISSERTATION

Presented to the Faculty of the Graduate School of

The University of Texas at Austin

in Partial Fulfillment

of the Requirements

for the Degree of

DOCTOR OF PHILOSOPHY

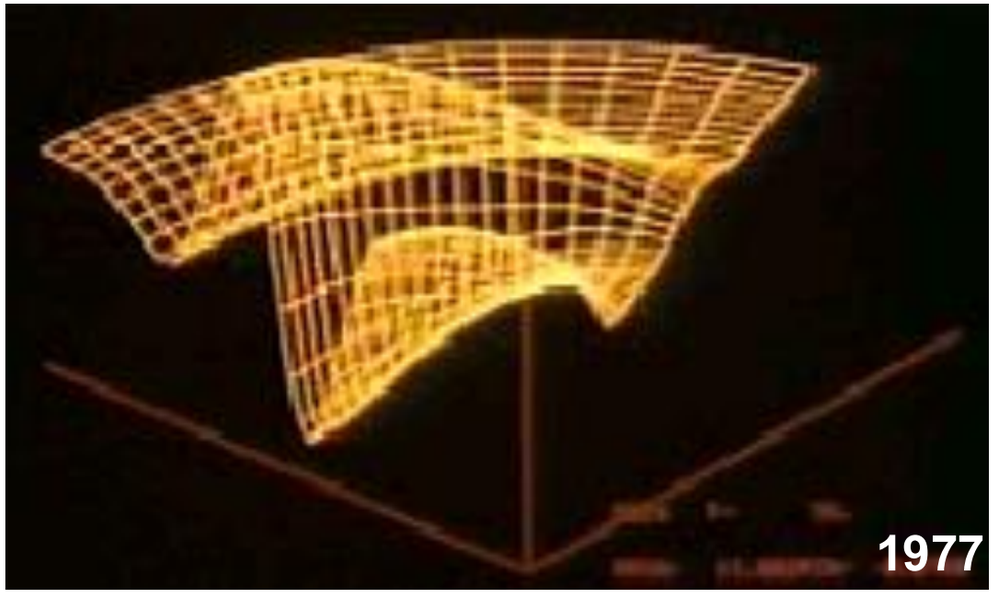
THE UNIVERSITY OF TEXAS AT AUSTIN

January 1975

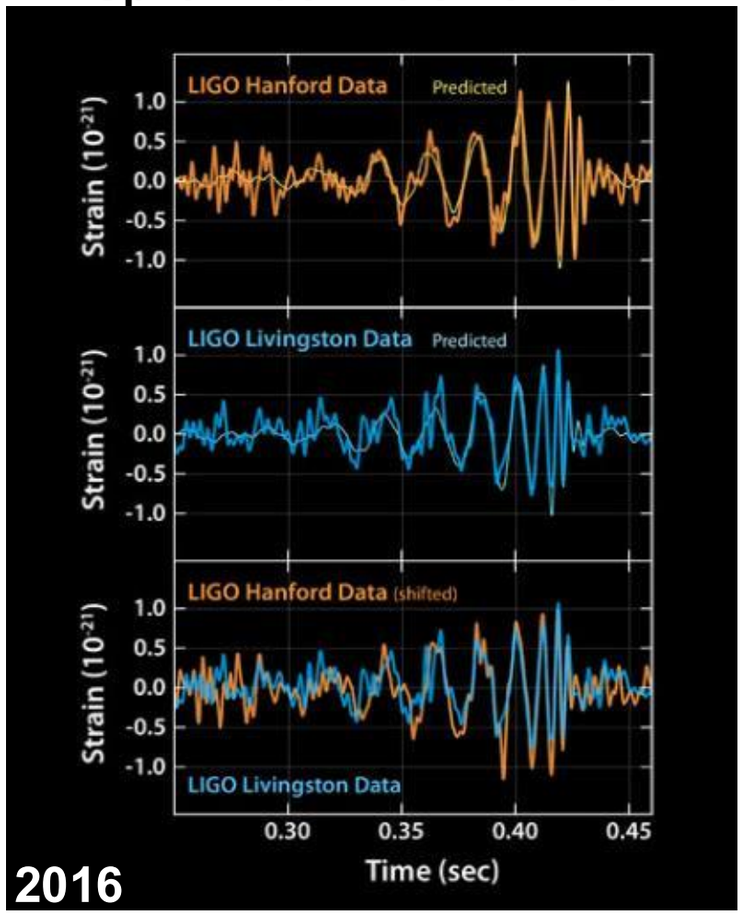
I Demonstrated in My PhD Dissertation That One Could Solve Computationally Einstein's Equations of General Relativity For the Head-On Collision of Two Black Holes

Forty Years of Computing Gravitational Waves From Colliding Black Holes – One Billion Times Increase in Supercomputer Speed!

L. Smarr and K. Eppley
Gravitational Radiation Computed from a Head-On Two Black Hole Collision



LIGO Consortium
Spiral Black Hole Collision



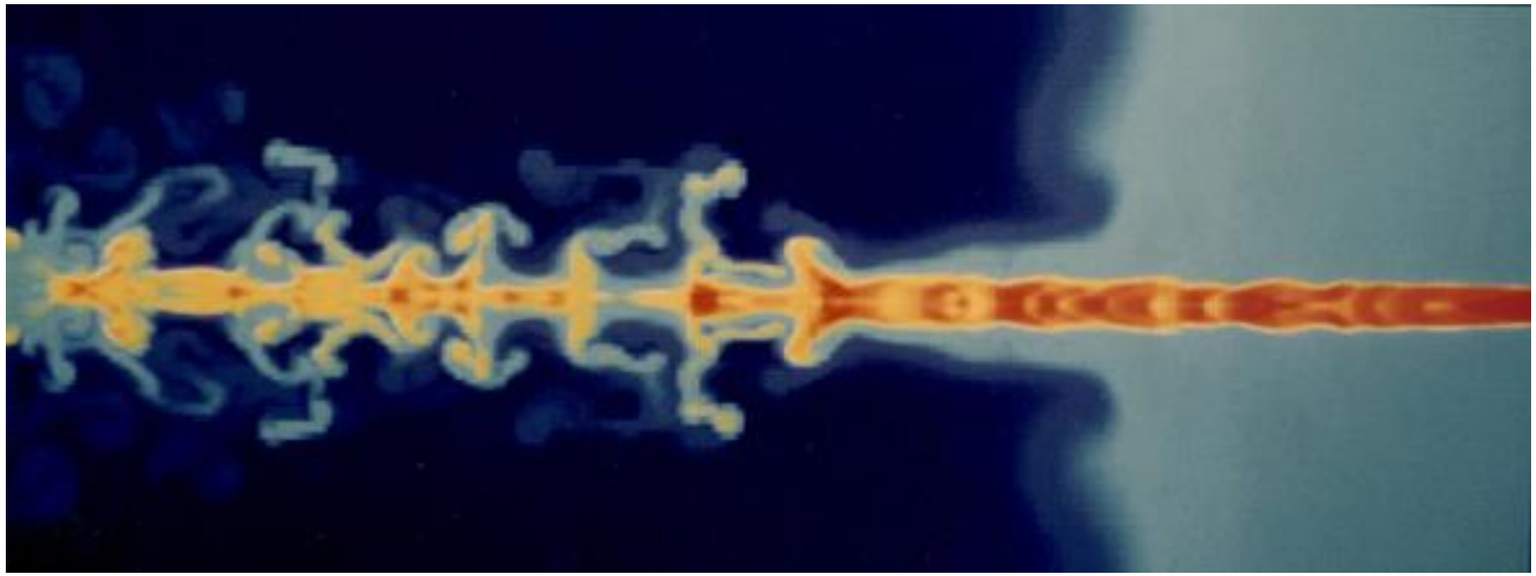
40 Years

MegaFLOPS → **1 Billion Times Faster** → **PetaFLOPS**

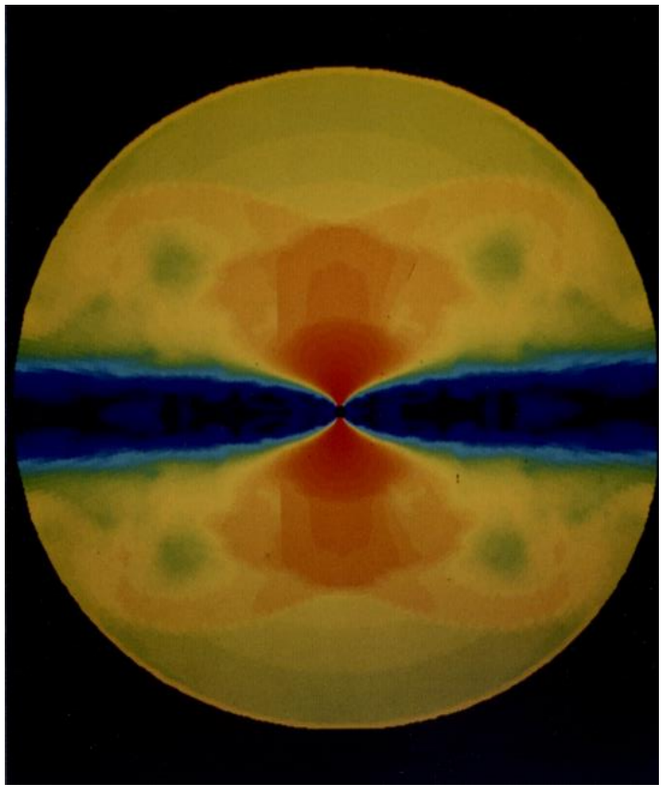
Holst, et al. Bull. Amer. Math. Soc 53, 513-554 (1916)

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MU Taught Me That I Could Solve Schrödinger's Equation with Computers -- Why Not Other "Laws of Physics" for Energetic Astrophysical Systems?



Navier-Stokes Shock Hydrodynamics:
Cosmic Jets Emerging From Galactic Center Black Holes
1981-1984



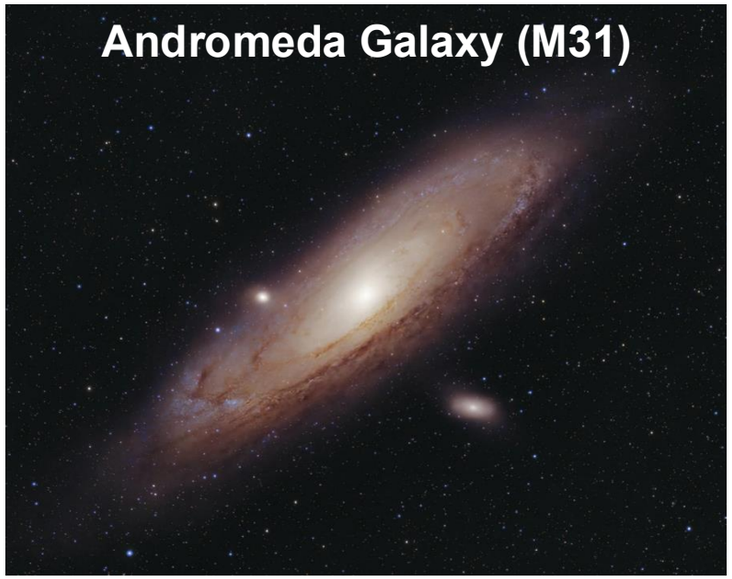
General Relativistic
Magneto-Hydrodynamics
Gas Accretion onto a Black Hole
1982-1985

To Gain Access to Supercomputers I Became a Visitor
at the Lawrence Livermore National Laboratory and
Then at Germany's Max Planck Institute for Physics and Astrophysics

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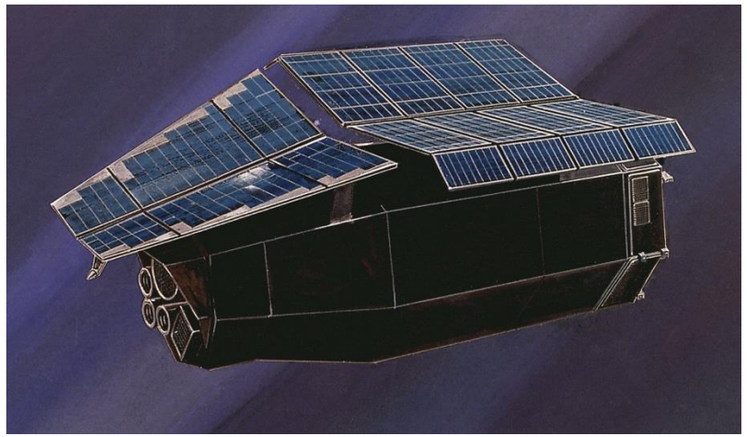
I Also Made Observations of the Andromeda Galaxy's Stellar Bulge Using X-Ray, Optical, and Radio Digital Telescopes From

1978-1983



Analysis of Digital Astronomy Also Requires Major Computational Support

Einstein X-Ray
High Energy Astronomy Observatory



National Optical Astronomy Observatory
Kitt Peak

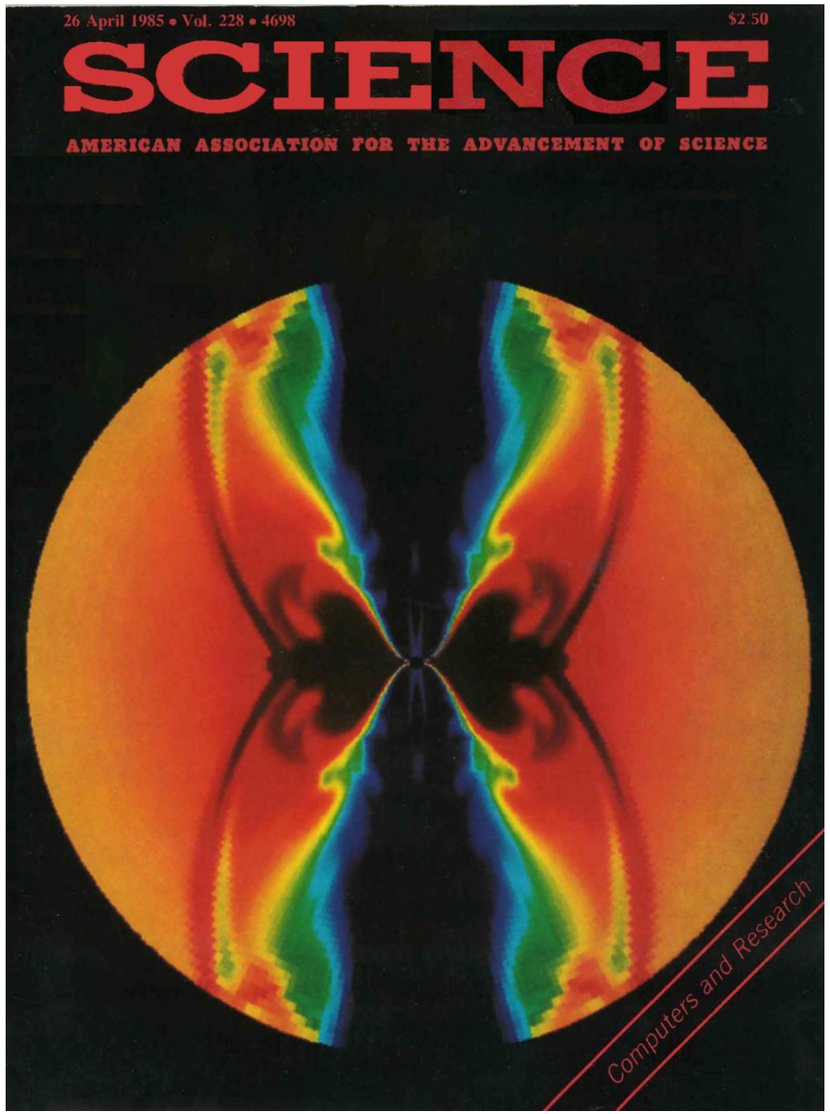


National Radio Astronomy Observatory
Very Large Array



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The Computational Sciences are Joining the Mathematical and Experimental/Observational Sciences



Science April 26, 1985

An Approach to Complexity: Numerical Computations

Larry L. Smarr

"The use of supercomputers and modern color-imaging techniques for numerical computation are beginning to fulfill von Neumann's vision that computers would become the most appropriate tool for solving nonlinear partial differential equations."

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Documenting The Unmet Supercomputing Needs of University Researchers Over A Broad Range of Disciplines Led to the NCSA Proposal to NSF

1982

1983

1985

THE SUPERCOMPUTER

A

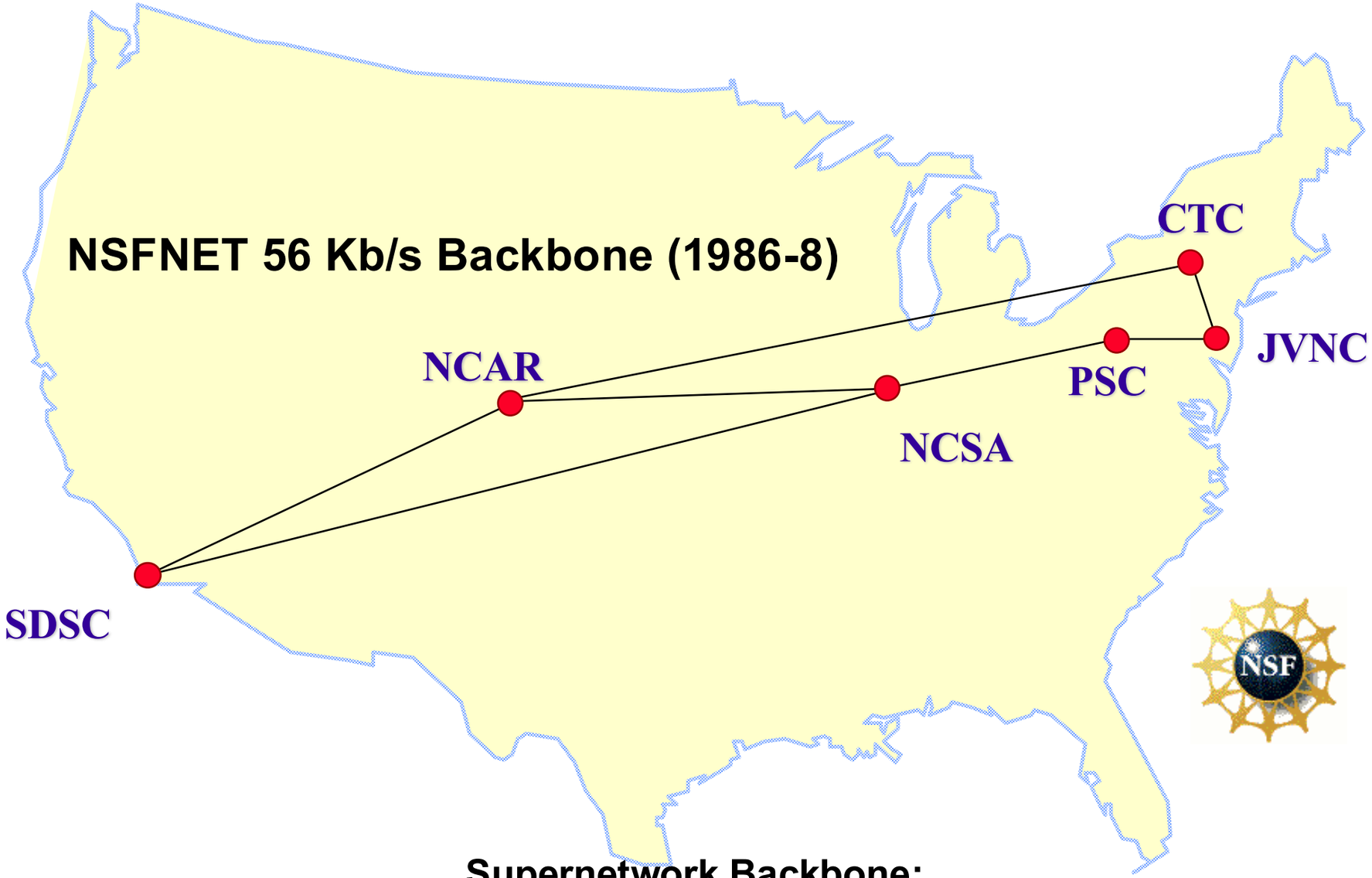
Department

University of



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Launching the Nation's Information Infrastructure: NSFnet Supernetwork Connecting Six NSF Supercomputers



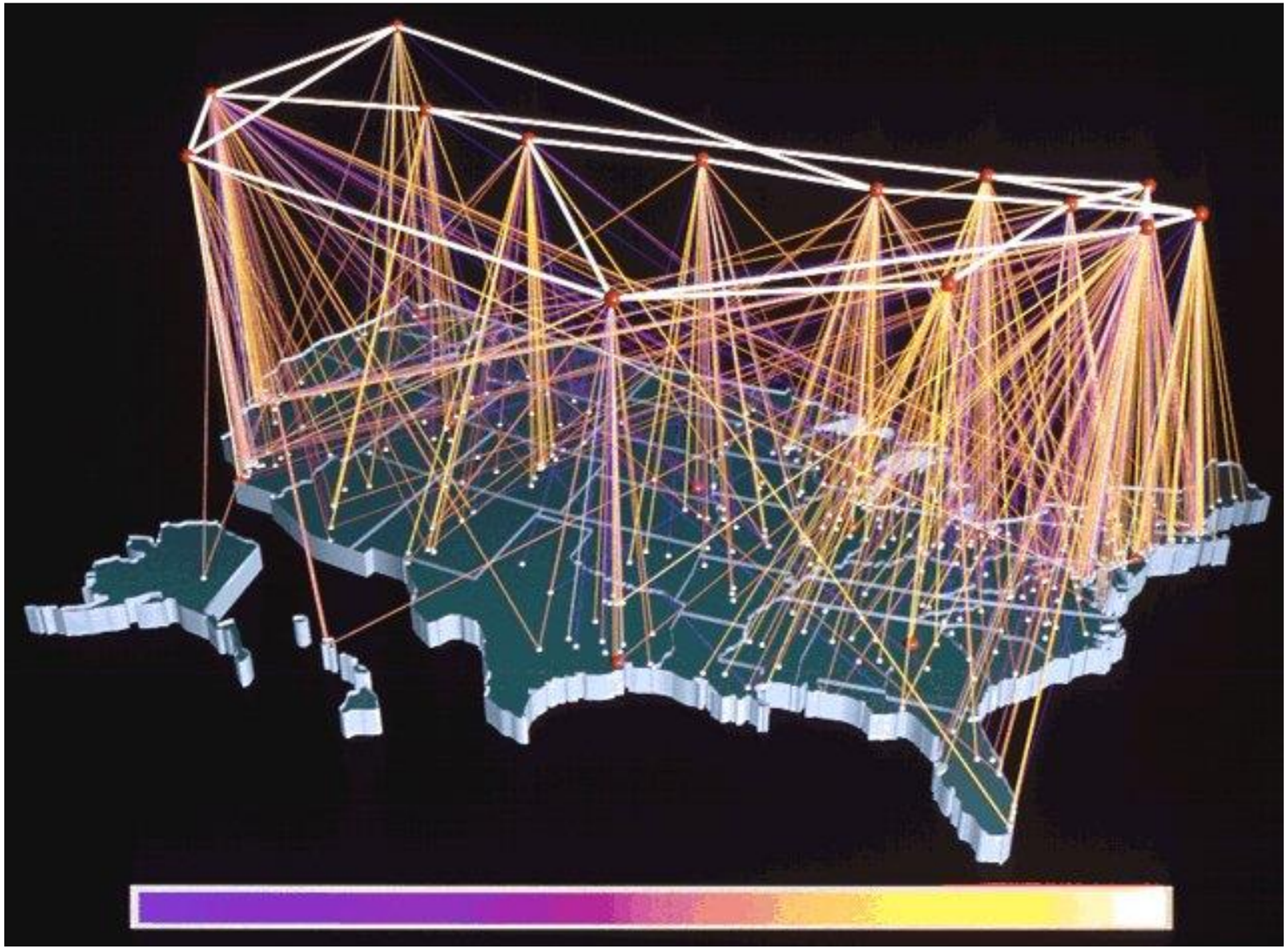
Supernetwork Backbone:
56kbps is 50 Times Faster than 1200 bps PC Modem!

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The Internet Backbone Bandwidth Grew 1000x in Less Than a Decade

Today's Internet2 Backbone is 10,000 Times Faster Than in 1994

A 10 Million-Fold Increase Over The 1996 NSFnet Backbone!

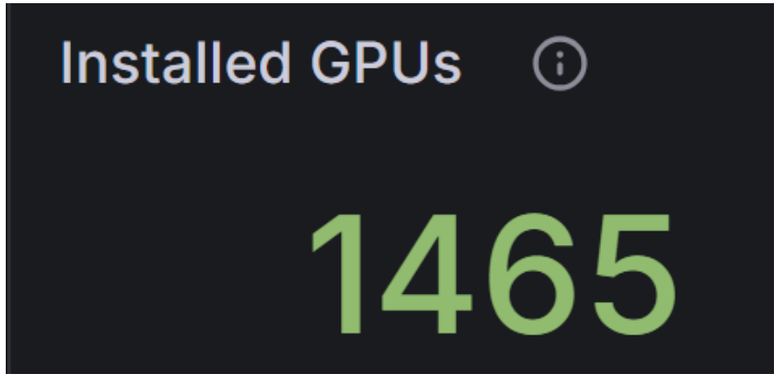


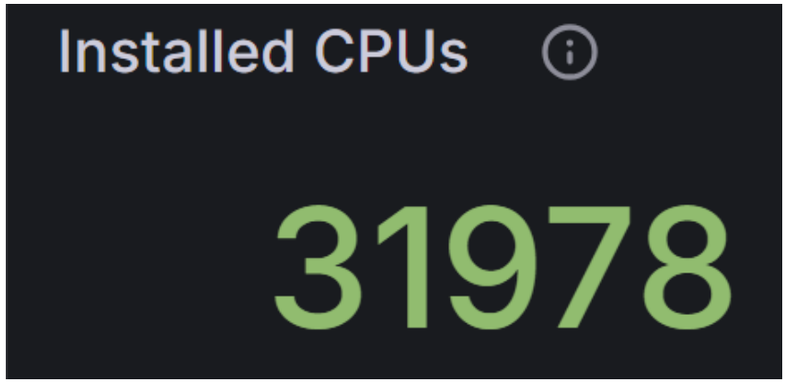
Visualization by NCSA's Donna Cox and Robert Patterson
Traffic on 45 Mbps Backbone December 1994

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For the Last 20 Years I Have Been Building Out The National Research Platform (NRP): a Distributed *Academic* Compute/AI Cloud with Nodes Hosted on Campuses

Current NRP Capacity Available to Researchers



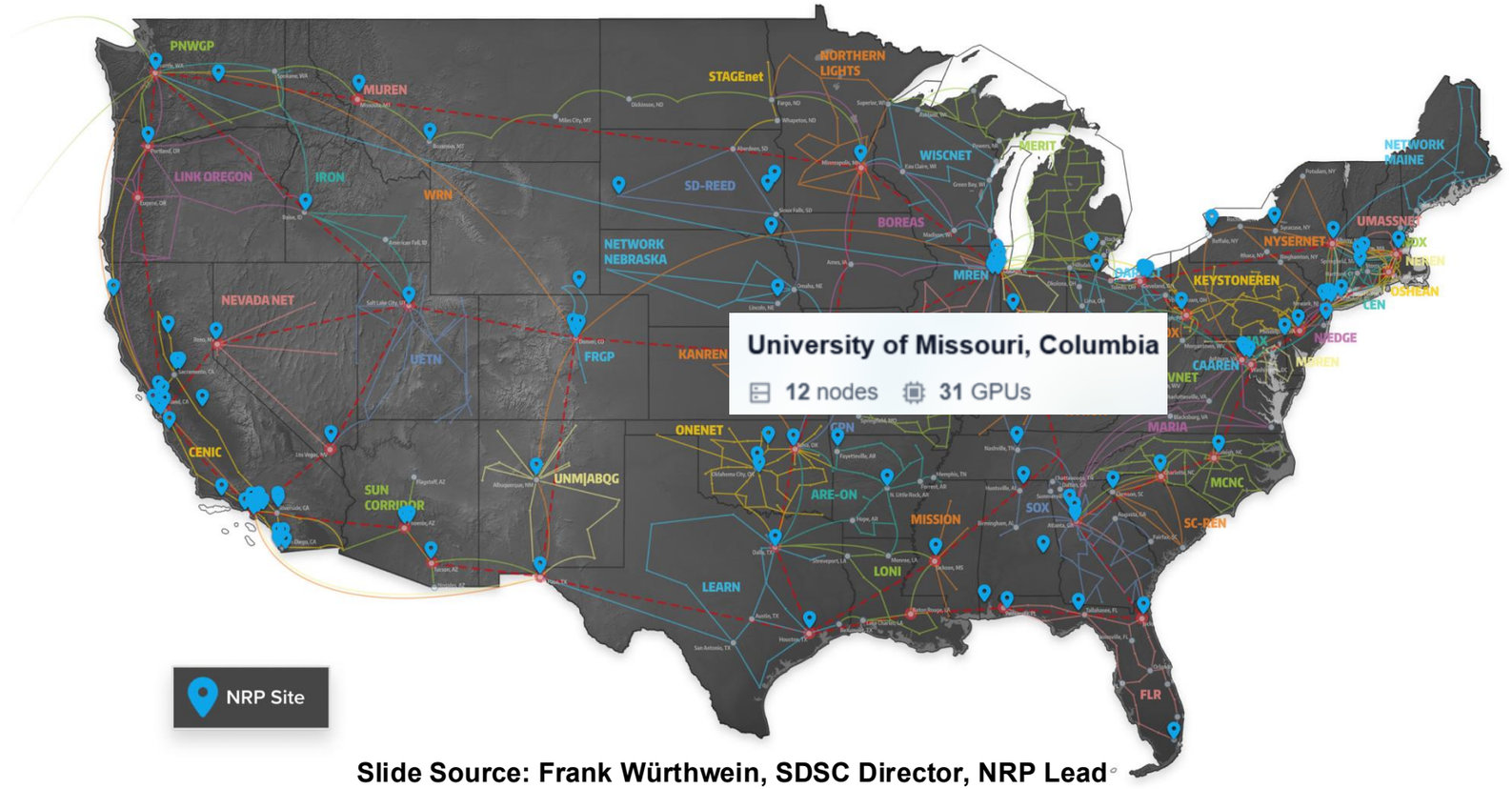


UMC NRP GPU Usage in Calendar 2025:
300,000 GPU-Hours
Fifth Largest Campus Usage in US!

National Research Platform: 82 institutions with 126 data centers

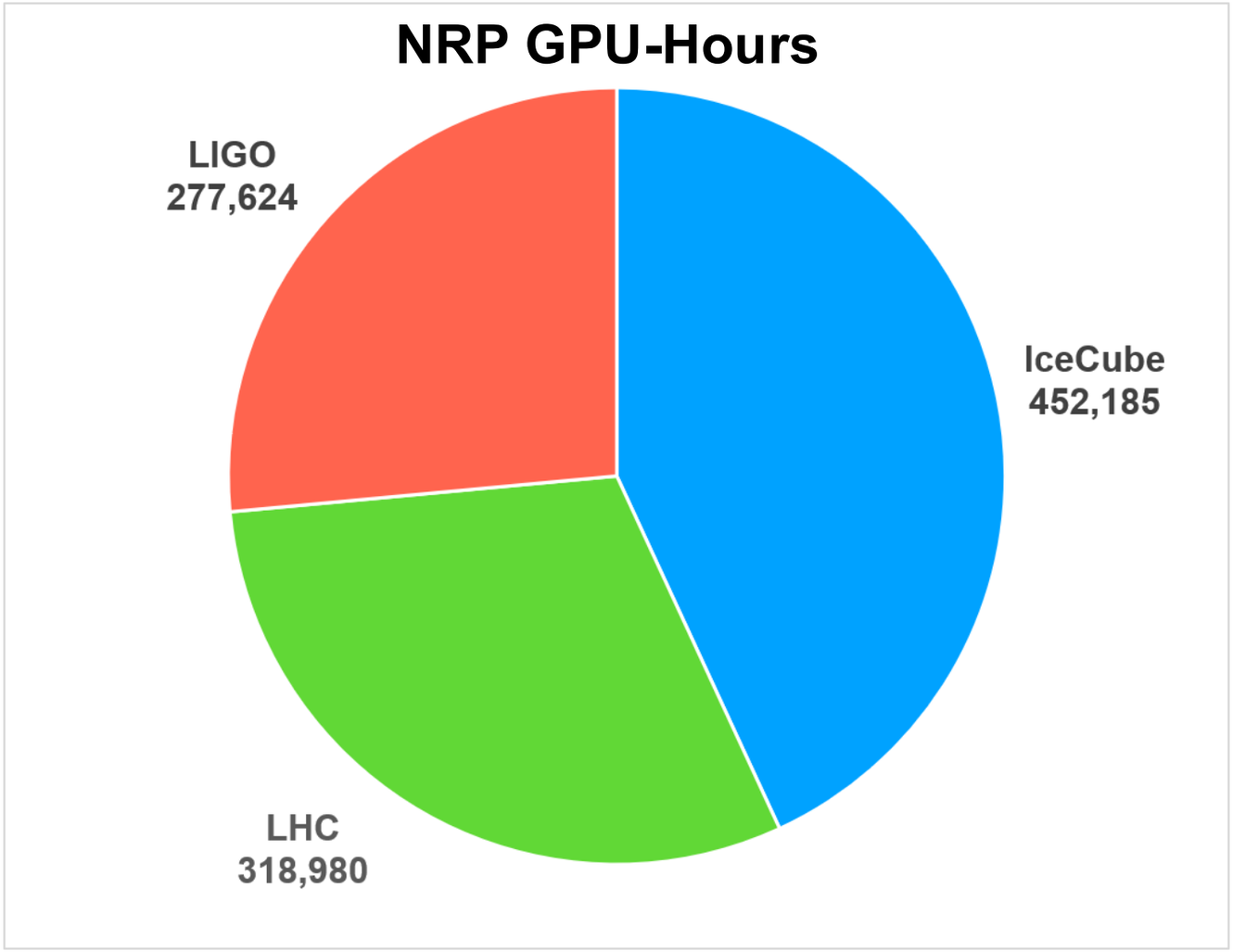
- 36 R1 colleges
- 28 non-R1 colleges
- 13 Research & Education Networks
- Some National and State labs and a Museum

NRP Locations Overlayed on the National Research and Education Internet Backbone



Slide Source: Frank Würthwein, SDSC Director, NRP Lead

One of the Largest GPU Users of the NRP: Physics and Astronomy Detector Data Analysis



Total Usage Over 1 Million NRP GPU-Hours in Calendar 2025!

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